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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/813,240	03/20/2001	Wilfried Von Ammon	VON AMMON ET AL 9	1729

7590 01/16/2002  
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EXAMINER

MONDT, JOHANNES P

ART UNIT

PAPER NUMBER

2826

DATE MAILED: 01/16/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/813,240

Applicant(s)

AMMON ET AL.

Examiner

Johannes P Mondt

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM  
THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 26 June 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-6 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All b) ☐ Some \* c) ☐ None of:  
1. ☒ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4. 6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### ***Information Disclosure Statement***

The examiner has considered the items listed in the Information Disclosure Statement and Supplemental Information Disclosure Statement entered as paper No. 4.

### ***Claim Rejections - 35 USC § 102***

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. *Claim 1 is rejected* under 35 U.S.C. 102(b) as being anticipated by Jacob (German patent DE 3545383 A1). Jacob teaches in claim 1 (page 2, lines 1-19) the doping of silicon wafers with hydrogen at a concentration in the range of more than  $10^{15}$  atoms /  $\text{cm}^3$ , which range overlaps with the range stated in Applicants' claim. Therefore, Jacob anticipates claim 1.

### ***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. *Claim 2 is rejected* under 35 U.S.C. 103(a) as being unpatentable over Schmidt et al (4,210,486) in view of the publication by Surma et al (ASDAM '98, 2<sup>nd</sup> Int. Conf. on Advanced Semiconductor Devices and Microsystems 1998). Schmidt et al teach the doping with hydrogen of semiconductor materials, especially silicon, with a doping concentration in the range stipulated by Applicant ( $1.67 \times 10^{14}$  atoms / cm<sup>3</sup>) (see column 3, lines 26-33 and column 4, lines 1-5).

Schmidt et al do not specifically teach the Czochralski method for growing the crystal nor do they stipulate the partial pressure of hydrogen to be less than 3mbar.

However, the use of the Czochralski method to grow a crystal that can be pulled from a melt in the presence of hydrogen under a partial pressure of hydrogen less than 3 mbar is common among those skilled in the art as witnessed by the publication by Surma, who teach the use of hydrogen plasma for hydrogen doping of Czochralski silicon crystals at a pressure of 250 mTorr (roughly 0.3 mbar), hence less than 3 mbar. (see page 47, "Experimental Details" – page 48, line 9, particularly line 3), in order to achieve the desired doping result.

Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention at the time it was made so as to include the proscription that the silicon single crystal be pulled from a melt within the context of the (single-crystal) Czochralski method in the presence of hydrogen, wherein the silicon single crystal is pulled under a

hydrogen partial pressure of less than 3 mbar. Finally, to get the wafer it is inherent to separate the wafer (slice) from the silicon crystal as a whole.

5. *Claim 3 is rejected* under 35 U.S.C. 103(a) as being unpatentable over Schmidt et al and Surma et al as applied to claim 2 above, and further in view of Tamatsuka et al (6,191,009 B1). As detailed above, claim 2 is unpatentable over Schmidt et al in view of Surma et al, who, however, do not necessarily teach the method of claim 2 to comprise doping the silicon single crystal with nitrogen and producing a nitrogen concentration in the range of  $5 \times 10^{12}$  to  $5 \times 10^{15}$  atoms /  $\text{cm}^3$ .

However, for the purpose of reducing crystal defects in Czochralski single semiconductor, especially silicon, crystals by the method of doping the crystal ingot with nitrogen is well known by those skilled in the art, as witnessed by Tamatsuka et al, who teach through their claim 2 a method for producing a single silicon crystal wafer by subjected it to an atmosphere including hydrogen (independent claim 1 in Tamatsuka et al) but also comprising nitrogen, doped in the crystal at a concentration in the range between  $10^{10}$  and  $5 \times 10^{15}$  atoms/ $\text{cm}^3$ , a range that significantly overlaps with the range stipulated by Applicants.

Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention at the time it was made so as to include into the method of claim 2 of Applicants the doping of the silicon single crystal with nitrogen and producing a nitrogen concentration in the range of  $5 \times 10^{12}$  to  $5 \times 10^{15}$  atoms /  $\text{cm}^3$ .

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6. *Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schmidt et al and Surma et al as applied to claim 2 above, and further in view of Kim et al (5,942,032) and Tamatsuka et al (6,299,982 B1).* As detailed above, claim 2 is unpatentable over Schmidt et al in view of Surma et al, who, however, do not necessarily teach the further limitation of claim 4. However, the use of a heat shield in the context of the Czochralski method for selectively shielding a semiconductor single crystal ingot is widely known in the art; see Kim et al (cf. abstract and claim 1 starting at column 10); the time scale of the cooling process is commonly known to be related to the time it takes for diffusion processes to complete within the crystal. An acceptable cooling rate is given by Tamatsuka et al (6,299,982 B1), for cooling from 1150 to 1080 degrees as 2.3 degrees per minute or more (cf. abstract, first two sentences). For the present cooling from 1050 to 900 degrees this yields a cooling time of  $150/2.3$  or less than 66 minutes, which is less than 120 minutes. Finally, the examiner takes official notice that the diffusion rate mentioned above that delimits the required cooling rate does not vary between 1150 degrees and 900 degrees significantly enough to require a different cooling rate for Tamatsuka's and Applicants' temperature ranges.

Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention at the time it was made so as to proscribe the method of claim 2 to comprise the placing of a cooled (inherent) heat shield round the silicon single crystal and cooling the silicon single crystal with the heat shield for a period of time within which the silicon single crystal cools from a temperature of 1050 degrees centigrade to a temperature of 900 centigrade in less than 120 minutes.

7. *Claim 5 is rejected* under 35 U.S.C. 103(a) as being unpatentable over Schmidt et al and Surma et al as applied to claim 2 above, and further in view of Iida et al (6,197,109 B1). As detailed above, claim 2 is unpatentable over Schmidt et al in view of Surma et al, who, however, do not necessarily teach the further limitation of claim 5. However, Iida et al disclose a method for producing a silicon single crystal through the Czochralski method comprising out-diffusing excessive nitrogen by performing the heat treatment in an atmosphere consisting of hydrogen, argon or a mixture of hydrogen and argon (cf. column 9, lines 53-60), i.e., the mixture of hydrogen and argon has a volume percentage of hydrogen between 0 and 100 %, which overlaps with the range of less than 3% given by Applicant. Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention at the time it was made so as to include the subjecting of the semiconductor wafer to a heat treatment in an atmosphere containing less than 3 % by volume of hydrogen and the balance being argon.

8. *Claim 6 is rejected* under 35 U.S.C. 103(a) as being unpatentable over Schmidt et al and Surma et al as applied to claim 2 above, and further in view of Tamatsuka et al (6,224,668). As detailed above, claim 2 is unpatentable over Schmidt et al in view of Surma et al, who, however, do not necessarily teach subjecting the semiconductor wafer to an oxidation treatment. However, the inclusion of oxygen as a reactant in the atmosphere during heat treatment within the context of the Czochralski method of producing a silicon single crystal wafer with reduced defects is well known in the art as

exemplified by Tamatsuka et al (6,224,668) who teach the use of an atmosphere of hydrogen, argon, oxygen, and mixed gases thereof (cf. column 9, lines 36-41) to the single silicon crystal on insulator (SOI) substrate. Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention at the time it was made so as to include subjecting the semiconductor wafer to an oxidation treatment.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is 703-306-0531. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 703-308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

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JPM  
January 5, 2002



Nathan Flynn  
Primary Examiner